Space Weather Technical Forecast

Issued on Tuesday, 01 February 2022 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1-G2 Minor to Moderate Storms likely day 2 (02 February) from CME arrival. Chance M-flares (R1/R2 Radio Blackouts). Active electron fluence expected day 1 (01 February).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity is low with a number of C-class flares observed, The majority of these originated from AR2940 (Esi/Beta) near the northeast limb), AR2939 (Dai/Beta) in the northeast quadrant and occasionally from AR2936 (Eho/Beta), a large but apparently stabilising region in the northwest quadrant. Two other sunspot regions are simple, stable or fading alpha regions. No Earth-directed CMEs were observed in available imagery in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 started at close to 500km/s but has slowly declined and was averaging close to 400km/s at the end of the period. Density has been mainly around or slightly below average. Total interplanetary magnetic field strength, Bt, was mostly weak. The north-south component however was weakly negative until 31/1700UTC when it reverted to a positive orientation. Phi angle started negative (towards the Sun) but soon rotated into a positive orientation and remained so for the rest of the period. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), started at moderate levels, but reached the high (1e3pfu) threshold at 31/1045UTC and remained above this level through much of the period, returning to moderate levels at 31/2105UTC. Associated electron fluence displayed a steadily rising trend but remained below the Active threshold (1e8 integrated flux), with 7.9e7 recorded at 01/0000 UTC.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be mainly low, with a chance of M-class flares, mainly from AR2939 and AR2940, with a further risk of AR2939. There is also a slight risk of X-class flares from these three regions.

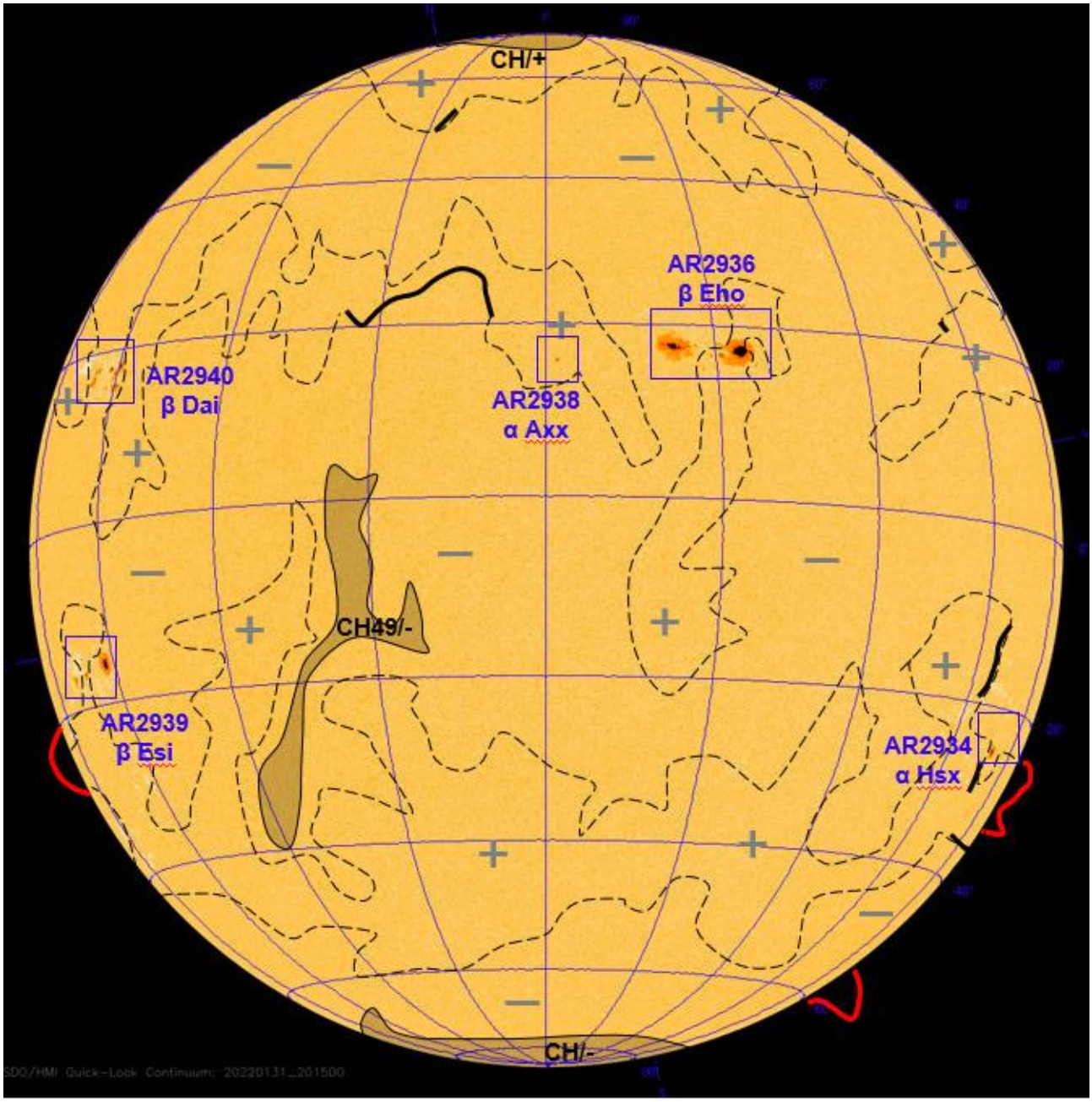
Solar Wind / Geomagnetic Activity: A CME which left the Sun on 29 January is forecast to arrive at Earth either late on 01 February or during 02 February. Solar winds are expected to continue to decline through 01 February in advance of any CME effects. A further high speed stream from coronal hole 49 may connect with the Earth on 04 February. Geomagnetic activity will start Quiet to Unsettled, but will become Active due to the CME arrival, with a likelihood of G1 or G2 (minor or moderate storm) intervals. There is also a slight chance of G3 strong storms. Activity should then decline on 03 February, with a further risk of G1/Minor Storms on day 4 due to the possible connection to the coronal hole high speed stream.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to be at background levels but with a slight chance of rising close to or just above the S1 level, given any significant flaring, predominately from AR2936. High energy electron flux (greater than 2MeV) is expected to exceed the high (1e3 pfu) threshold on 01 February. This will then drop out and become inhibited due to the geomagnetic activity from the CME arrival and high speed stream connection. Electron fluence is expected to reach the Active (1e8 integrated pfu) threshold on 01 February, but then sharply decline from 02 February due to increased geomagnetic activity.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 31/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

A CME which left the Sun on 29 January is expected to arrive at Earth either late on 01 February, but more likely on 02 February. The CME left the Sun as an asymmetric full halo, with a slight eastward bias, but is still likely to arrive at Earth.

Fast solar winds from coronal hole 47 are currently easing, with this easing expected to continue through 01 February. The high speed stream from coronal hole 49 is then forecast to connect with Earth either late on 4 February or during 05 February beyond the end of the forecast period. This forecast is based on persistence and despite the hole being in a similar region of the Sun to the equivalent hole on the last rotation, there is some uncertainty in actual timing. Speeds of 600km/s are possible from this coronal hole, although again this is subject to slight changes in the shape and position of the hole from the last rotation.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled on 01 February (day 1), but then increase either later on 01 or on 02 February (day 1 or day 2) due to the forecast arrival of the CME. This arrival is expected to result in Active intervals with a likelihood of G1/Minor Storms or G2/Moderate Storms. There is also a slight chance of G3/Strong Storm intervals. The effects of the CME arrival may then continue into 03 February (day 3). Further G1/Minor Storms are then possible late on day 4, due to the connection with the high speed stream from coronal hole 49.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	60	20	30
Strong	G3	No	5	15	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

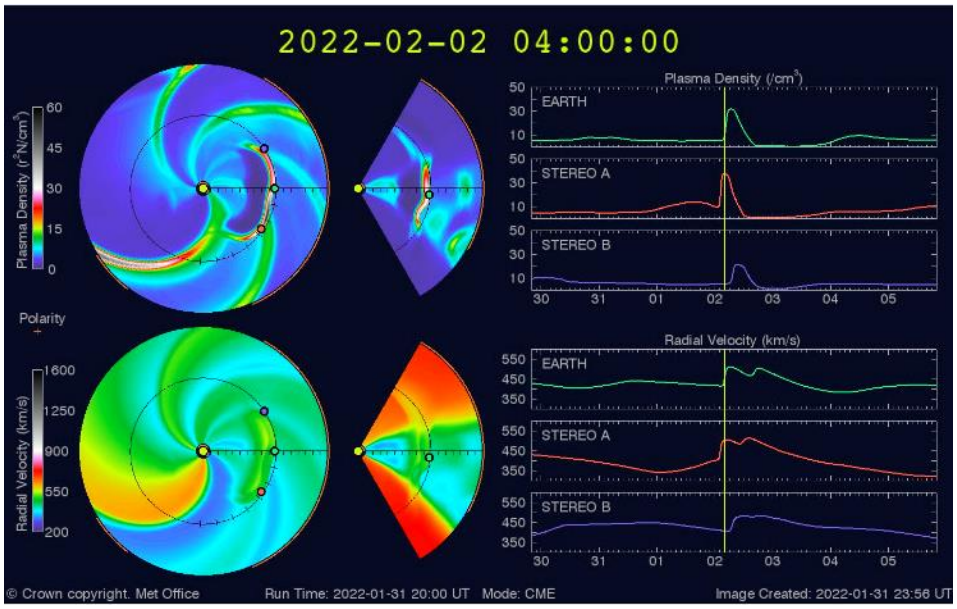
Geomagnetic Activity - Earthbound Coronal Mass Ejections

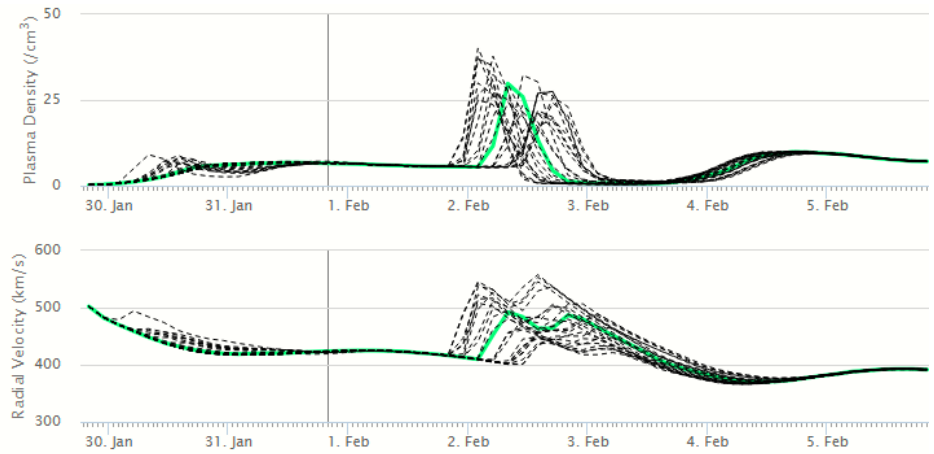
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/0633	Full (Asymmetric)	AR2936	08N 10E	540 km/s	02/0400 +/- 9 hours	CME slightly adjusted after reassessment.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 2: MOSWOC Enlil (top) showing most likely arrival times from CME which left Sun on 29 January. Enlil ensemble (bottom) demonstrates the range of possible arrival times and gives an indication of uncertainty.





Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

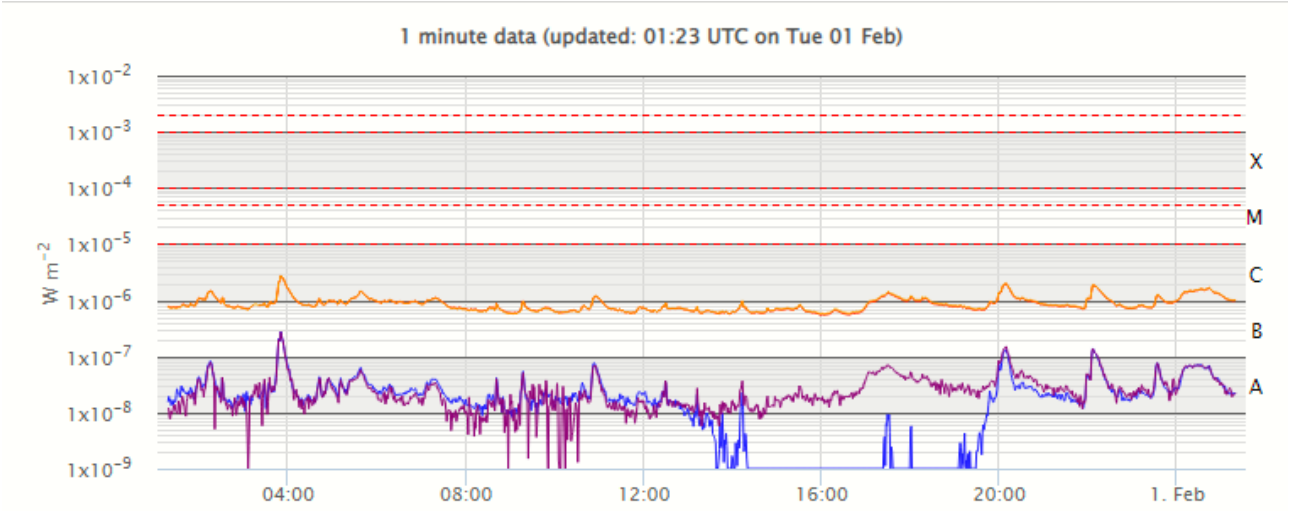
© Crown Copyright 2022. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
Solar activity is low, with frequent low level C-class flares, from AR2940, AR2939 and occasionally from AR2936. These could produce M-class flares and have a slight chance of X-class flares.

AR2936 (Eho/Beta) in the northwest sector is large but stable and has appeared to simplify over the last 24 hours. Despite this, the configuration of the region presents a slight risk of M-class flares and a very low risk of X-class flares. AR2939 (Esi/Beta) close to the southeast limb is an elongated, with AR2940 (Dai/Beta) more compact and complex. AR2934 (Hsx/Alpha) and AR2938 (Axx/Alpha) are both benign and stable regions.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-16 electron flux



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not likely in the period, however there is a slight chance for proton fluxes to rise given any significant flaring, predominately from AR2936 in the northwest quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has been increasingly persistent at high (1e3 pfu) levels with only brief dips to moderate levels. Further increases to high levels are likely on 01 February (day 1), but are then expected to drop to background as a result of the geomagnetic activity from the CME arrival either late on 01 or on 02 February. Any recovery in values is then subject to possible geomagnetic activity on 03 February (day 3) following the CME or to the effects of the high speed stream of coronal hole 49 on day 4.

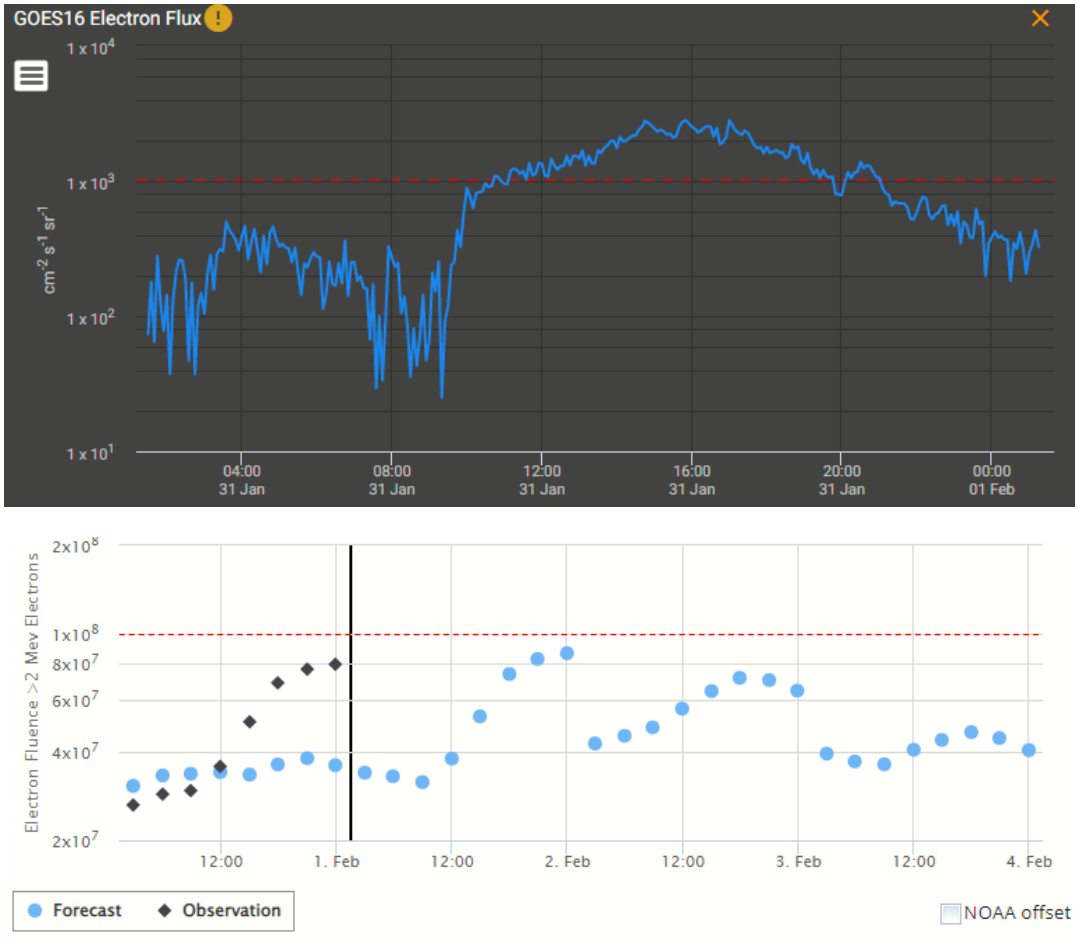
Electron fluence values are following a rising trend and are expected to exceed the Active (1e8 integrated pfu) on 01 February. Elevated values on 02 February (day 2) are subject to the arrival time of the CME. Geomagnetic activity on days 3 and 4 should inhibit any significant increase in electron fluence values.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	70	50	20	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 4: GOES 16 electron flux (top) and MOSWOC REFM model (bottom)



© Crown Copyright 2022. All Rights Reserved.